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MOBILE SONAR TECHNOLOGY INFORMATION BANK.(U)
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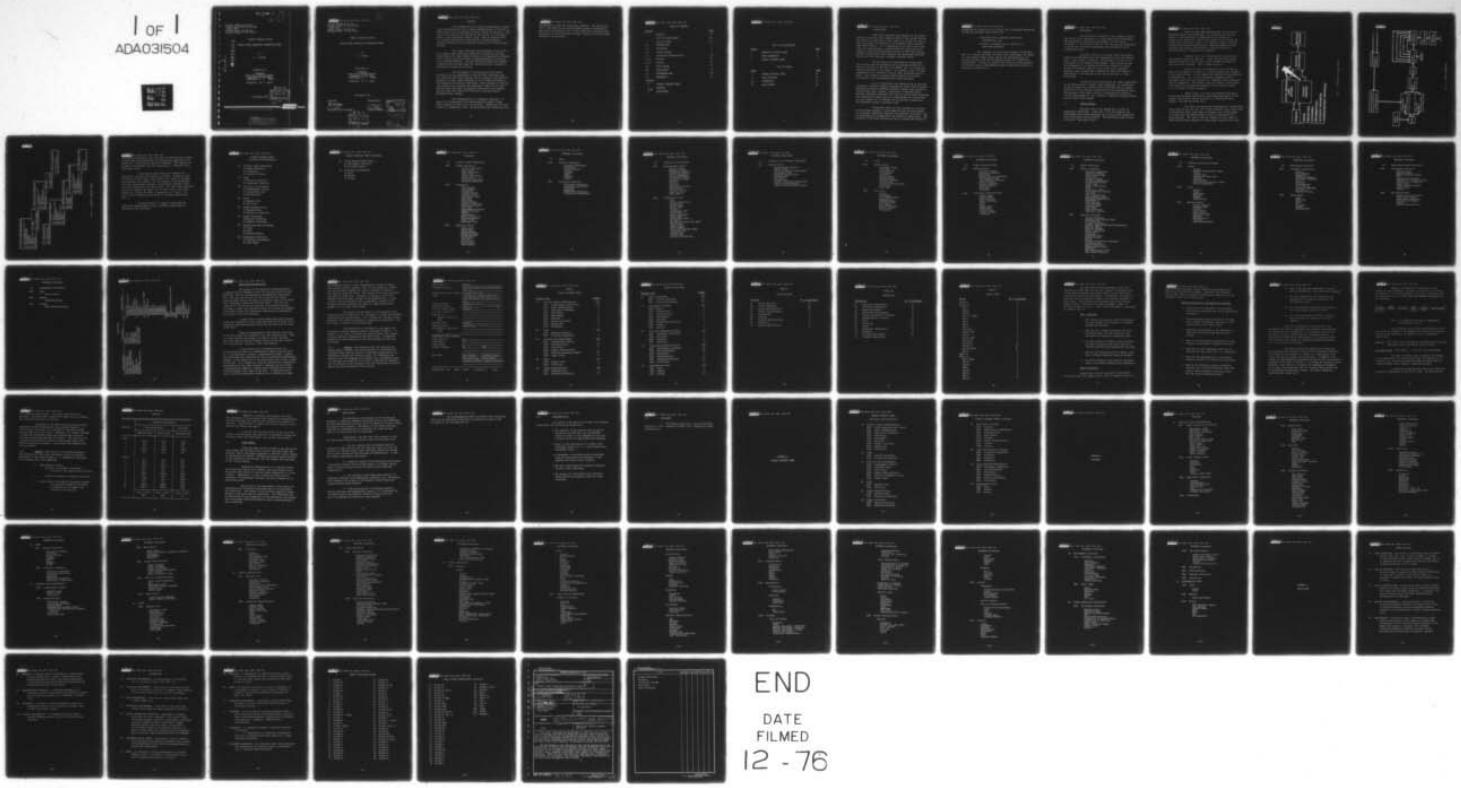

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Contract N00024-71-C-1132
Project Serial SF 111-111-500
Task 12851
TRACOR Project 037 001 01
Document Number T72-AU-9582-U

SUMMARY PROGRESS REPORT

MOBILE SONAR TECHNOLOGY INFORMATION BANK

by

J. L. Bardin

Submitted to

Commander
Naval Ship Systems Command
Department of the Navy
Washington, D. C. 20360

Attention: Mr. C. Smith

10 October 1972

TRACOR

6500 Tracor Lane, Austin, Texas 78721, AC 512/926-2800

TRACOR 6500 TRACOR LANE, AUSTIN, TEXAS 78721

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Assistant Vice President

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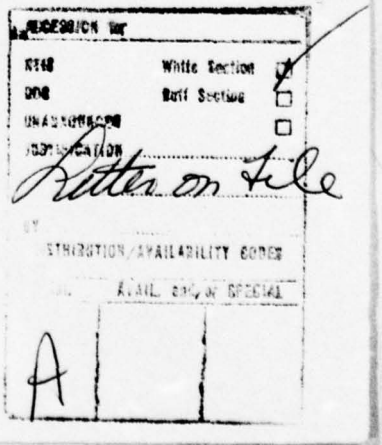
Program Manager



ABSTRACT

The documents held in libraries pertaining to mobile sonar technology are of quite limited useage because of the lack of sensitivity in the storage and retrieval systems in operation. That such is the case will be confirmed by the results of a literature search in any appropriate subject field. What is required then, is a storage and retrieval system which is characterized by successful operation in fine-grained searches and in broad subject searches.

This report describes the development of the basis for a mobile sonar technology information storage and retrieval system which will induce centralization of the appropriate documents into a library and will provide a reasonable method of accession to the desired documents. The work herein described has produced a concept which has been named the "descriptive word" approach to information storage and retrieval.

The development of the descriptive word system involved first the organization of mobile sonar technology into ten categories which were derived from an overview of the physical process of a sonar system operating in its intended environment; the categories were further subdivided. Next, elements to describe other aspects of a document were generated. These are the sonar function concerned with, the general orientation of the subject, the key words, and finally the notation of any specifically designated sonar systems.

The representation of a document, therefore, is made to be a descriptive word (containing the elements listed above) instead of simply a set of key words. Whereas the key word systems are inadequate, today, the descriptive word system has been

demonstrated to offer the flexibility required. The feasibility test is described in this report wherein several representative questions from potential users of the system were translated into descriptive words and searches through a sample file of applicable documents were performed.

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1.0 INTRODUCTION

This report describes the progress on the subject contract during the first eighteen months of the contract period. The reason for reporting in such a way is to be able to refer to this one document for details of the complete system developed under this contract. It is appropriate to do such at this time since the system design is completed and the future work will consist of providing consultation services to PMS 302.4 and the NAVSHIPS Library while they integrate the development described herein into their automatic document retrieval system.

The motivation for developing the system under this contract was the recognition of an existing problem and a desire on the part of PMS 302.4 and TRACOR, Inc., to correct the situation created by the problem. The problem is that a visible organization (in a library) of mobile sonar technology does not exist. This creates a situation which permits only limited utilization of the technological base being developed.

One is frustrated by the insensitivity of existing information retrieval systems maintained at places such as Defense Documentation Center, NAVSHIPS Technical Library, Navy Laboratory libraries and other relevant repositories of documents which describe (and hence represent) the state of mobile sonar technology. Such insensitivity makes the job of summarizing the state-of-the-art with respect to a literature survey extremely unsatisfying and impossible within a reasonable time.

Alternatives which one must consider as solutions to the problem include (1) continuing with the existing systems, (2) producing "Technology Summaries" periodically (3-5 years), and (3) developing and implementing a new system of organization. The objective of the work reported here was to develop the design and

demonstrate the feasibility of a mobile sonar technology information storage and retrieval system which will

- Centralize sonar technology development documentation, and
- Provide a reasonable way of accession to individual documents.

The remainder of this report discusses the development of a logical structure for mobile sonar technology, the design of a utilization scheme (which implies the characteristics of a retrieval system), and the testing and results of a feasibility demonstration. Section 3.0 contains the conclusions made possible at this time; and, recommendations based on these conclusions are discussed in Section 4.0.

2.0 DISCUSSION

The information contained in the technical reports held by PMS 302.4 represents to a large degree the technological base generated by exploratory development in mobile sonar technology. A system which does not now exist must be established to permit the efficient comprehension and utilization of the technological base.

Basically, the goal of uniform sonar development cannot be accomplished until the technological basis for development is made visible in general, overall aspects as well as in the details of any branch of development. This visibility must be accompanied by an information retrieval scheme (or system) which will allow all types of users in the sonar community--sponsors, labs, universities, industry--to meet their needs in determining or contributing to the state-of-the-art in sonar development.

Visibility can be achieved by the proper organization of the subject areas of mobile sonar technology. An information retrieval system (or a filing system) based upon such an organization will allow efficient utilization of the technological base. This section of the report contains a description covering the initial design phase of such a system, a feasibility demonstration, and the final system design.

2.1 Initial Design

The first task in the design was to select an organization philosophy. Given that, a set of categories was established within which documents can be placed with appropriate other information and descriptors. The descriptors make up what is called a "descriptive word."

There are many organizations which one can use to partition mobile sonar technology. Our contention is that the effects of arbitrariness of categorization are reduced to a minimum if an adoption is made of the concept of structuring the system logic based upon a model of the physical process by which a mobile sonar system would perform. When the effects of arbitrariness are reduced, the chances for unique location (or identification) of a document are enhanced.

Consider Fig. 1 for a depiction of an overview of the physical process of interest. To get a better idea of what general categories could be used, a more detailed portrayal of the process was required. That is shown in Fig. 2.

One can use such an organization of the field, as shown in the figures, to relate in a logical sequence the elements of the subject field. In this manner the required limiting function is accomplished. That is, the appropriate categories can be identified easily and the documents (or subjects) can be separated into the categories. This limits, then, the number of descriptive words required by putting the document into the proper context (i.e., location in proper category).

Shown in Fig. 3 are the ten categories and appropriate sub-categories selected as being significant points in the process and as such could be the basis of a descriptive word system. This was the second step.

The final step toward the development of a descriptive word system was to list (for use in each category) sets of four types of descriptors which, when taken in sequence, give a high degree of insight into the understanding of what is represented in a given document. The idea is that the sequence of four types of descriptors and the category and sub-category selection will tend

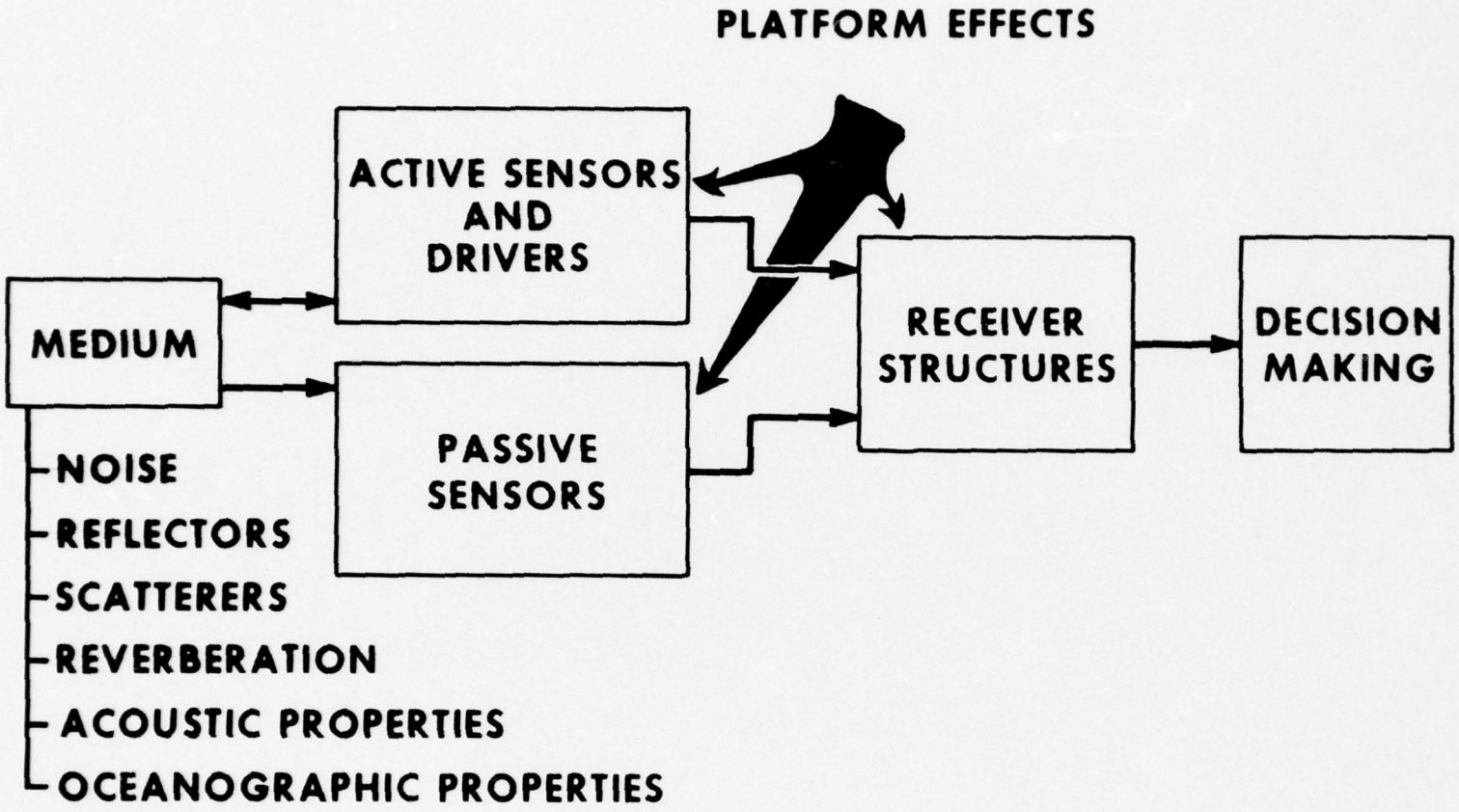

FIG. 1 - OVERVIEW OF MOBILE SONAR

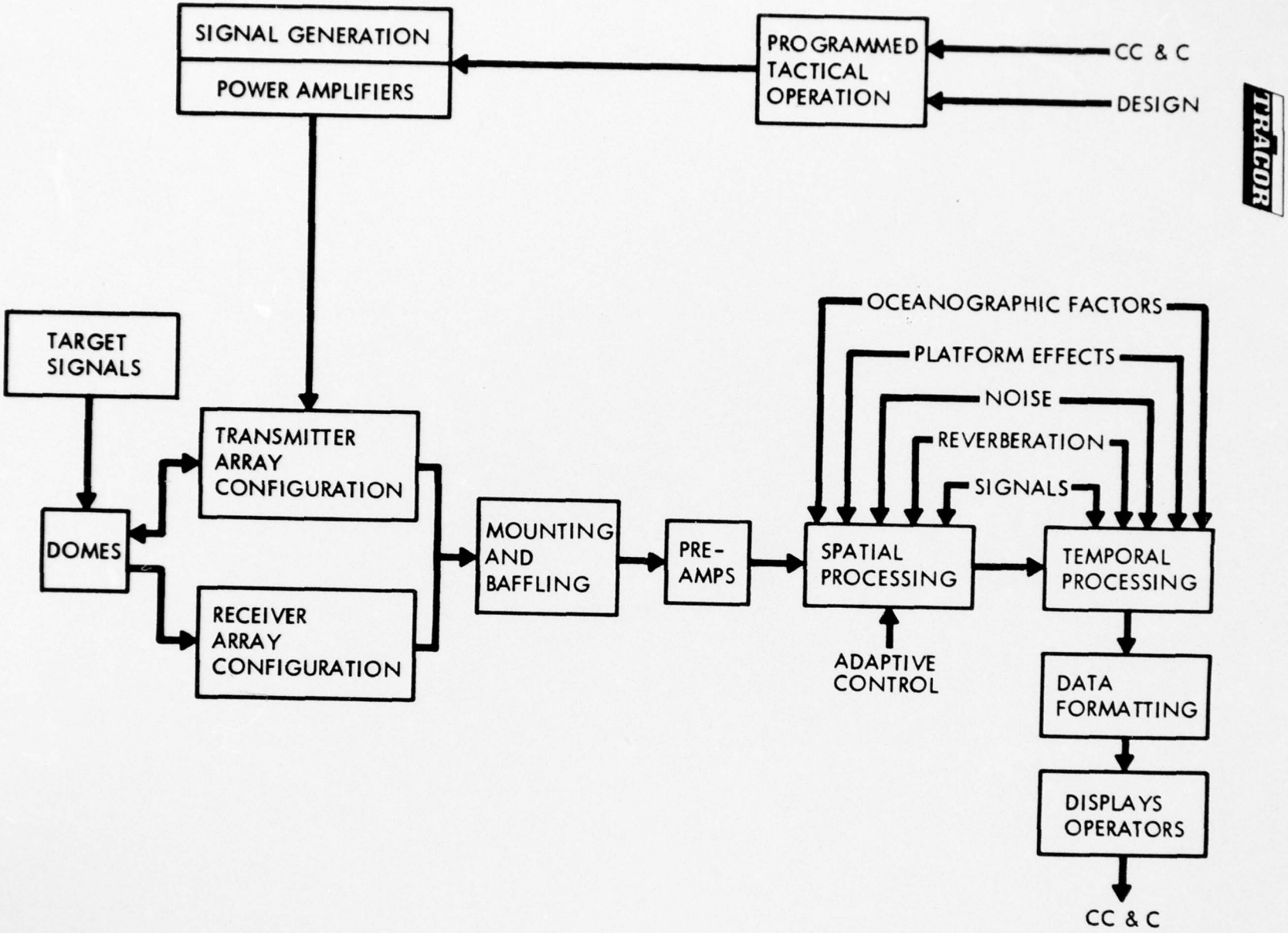

FIG. 2 - SONAR TECHNOLOGY

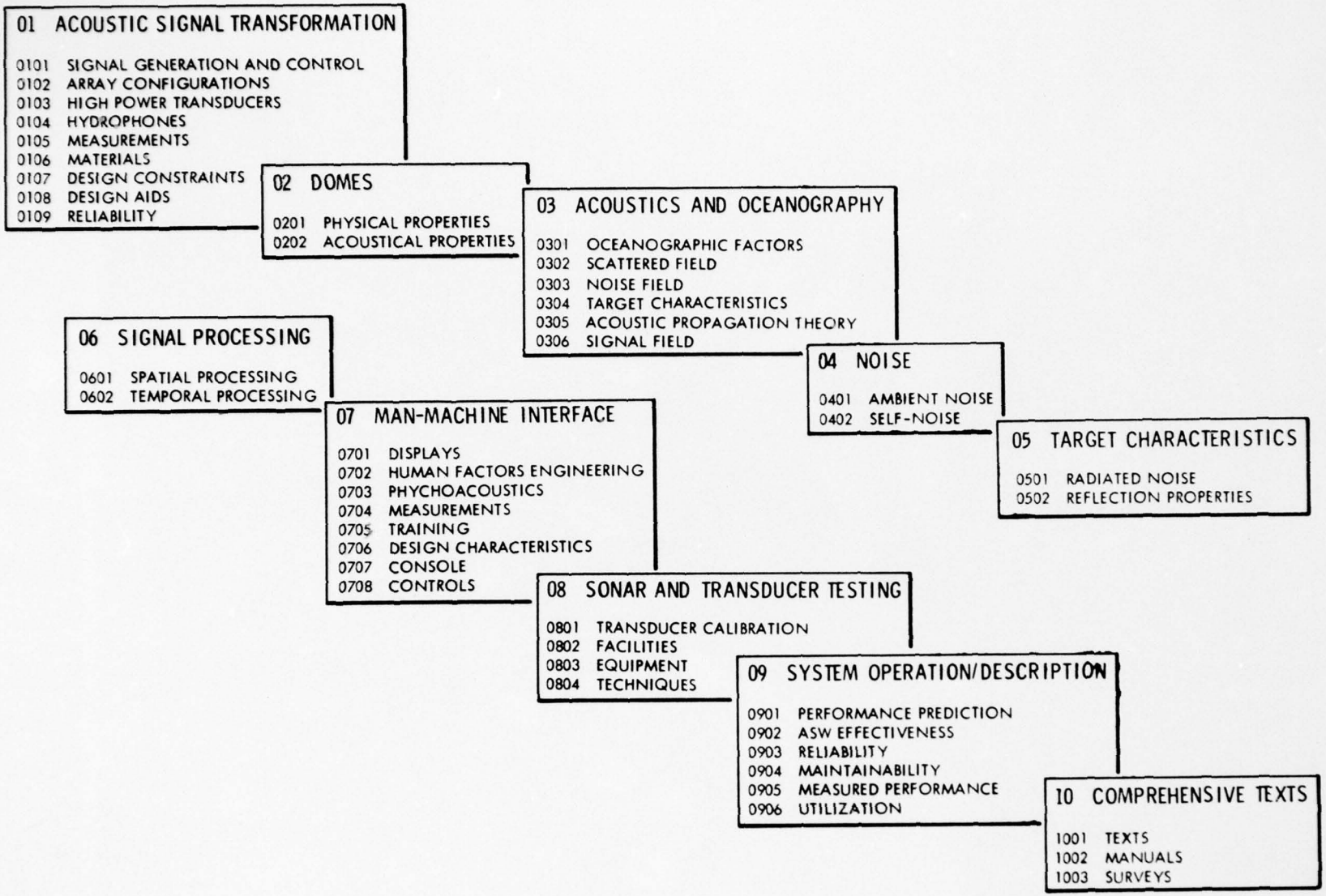

FIG. 3 - SUBJECT CATEGORY INDEX

to place the descriptors into the proper perspective--with respect to each other and with respect to applying some weighting of the descriptors to help better identify a document. The sequence of category, sub-category, and four descriptors is referred to as a descriptive word.

A descriptive word contains six elements and identifies a document with respect to content. Naturally, other information such as title, date, author, etc. would be included if a document were indexed. The six elements of the descriptive word were named Subject Category, Sub-Category, Keywords, Sonar Function, Orientation, and Sonar System. For lists which represent the initial design, see pages 9-22 of this report. The final design sets (lists) are shown in Appendices A, B, and C. The final list of keywords can be found in a separate publication, Ref. 1.

The next section 2.2, page 23, deals with the feasibility demonstration using a retrieval system based on descriptive word accession.

SUBJECT CATEGORY INDEX
(Including Sub-Categories)

01 Acoustic Signal Generation
- 01 Signal Generation
- 02 Transducers
- 03 Explosive Sources

02 Domes
- 01 Physical Properties
- 02 Acoustical Properties

03 Acoustics of the Medium
- 01 Oceanographic Factors
- 02 Transmission Loss
- 03 Reverberation

04 Noise
- 01 Ambient Noise
- 02 Self Noise

05 Target Characteristics
- 01 Radiated Noise
- 02 Reflection Properties

06 Signal Processing
- 01 Spatial Processing
- 02 Temporal Processing

07 Displays and Decision Making
- 01 Visual
- 02 Aural
- 03 Decision Making

08 Measurement Facilities
- 01 Transducer Calibration
- 02 Sonar Ranges

SUBJECT CATEGORY INDEX--Continued

09 System Operation/Description
- 01 Performance Prediction
- 02 ASW Effectiveness

10 Comprehensive References
- 01 Texts
- 02 Manuals
- 03 Surveys

KEYWORDS

01 Acoustic Signal Generation

0101 Signal Generation

- Control Amplifiers
- Duty Cycles
- Power Amplifiers
- Power Level
- Signal Programming
- Ships Power
- Switching Amplifiers
- Waveform Generators

0102 Transducers

- ADP Crystals
- Array Design
- Cavitation
- Conformal Array
- Current Control
- Cylindrical Array
- Duty Cycle
- Efficiency
- Element Design
- Element Interaction
- Equivalent Circuit
- Line Array
- Longitudinal Vibrator
- Magnetostrictive
- Piston
- Piezoelectric
- Quality Factor (Q)
- Shock Resistance
- Source Level
- Spherical Array

0103 Explosive Sources

- Bubble Pulse
- Cavitation
- Charge Weight
- Detonation Depth
- Energy Spectrum
- Flux Density
- Rise Time
- Scaling Laws
- Source Level
- Time Constant

KEYWORDS--Continued

02 Domes

0201 Physical Properties

Corrosion Resistance
Durability
Flow Properties
Fouling
Hardness
Shape
Strength
Weight

0202 Acoustical Properties

Absorption Coefficient
Array-Dome Interaction
Cavitation
Quenching
Reflection Coefficient
Transmission Coefficient

KEYWORDS--Continued

03 Acoustics of the Medium

0301 Oceanographic Factors

- Abyssal Planes
- Bathymetric Data
- Biological Organisms
- Bottom Composition
- Bottom Topography
- Continental Shelves
- Continental Slopes
- Pressure
- Salinity
- Sea State
- Temperature Profile
- Thermoclines
- Velocity Profile
- Wave Structure
- Wind Speed

0302 Transmission Loss

- Amos
- Arctic Transmission
- Attenuation
- Bottom Bounce
- Bottom Loss
- Colossus
- Convergence Zone
- Direct Path
- Energy Splitting
- Layer Depth
- Normal Mode Theory
- Ray Theory
- Reliable Acoustic Path (RAP)
- Shadow Zone
- Shallow Water
- SOFAR Channel
- Source and Receiver Depth
- Spreading Loss
- Surface Duct
- Surface Loss
- Temporal Stationarity

KEYWORDS--Continued

03 Acoustics of the Medium--Continued

0303 Reverberation

Amplitude Distribution
Bottom Bounce
Bottom Scattering Coefficients
Convergence Zone
Frequency Distribution
Grazing Angle
Sea State
Surface Duct
Surface Scattering Coefficients
Underice Reverberation
Volume Scattering Coefficients

KEYWORDS--Continued

04 Noise

0401 Ambient Noise

Biological Noise
Data Bank
Directionality
Isotropicity
Sea State
Seismic Noise
Shipping Noise
Spatial Coherence
Stationarity
Surface Generated Noise
Turbulence
Wind Speed

0402 Self Noise

Baffles
Cavitation
Flow Induced Noise
Isotropicity
Machinery Noise
Propeller Noise
Ship Speed
Spatial Coherence
Thermal Noise
Turbulence

KEYWORDS--Continued

05 Target Characteristics

0501 Radiated Noise

- Aircraft Carriers
- Continuous Spectrum
- Destroyers
- Diesel Electric Submarines
- Hydrodynamic Noise
- Line Component Spectrum
- Machinery Noise
- Nuclear Submarines
- Propeller Noise
- Ship Speed
- Torpedoes

0502 Reflection Characteristics

- Aspect Angle
- Doppler Shift
- Echo Structure
- Energy Splitting
- Fish
- Mines
- Pulse Length
- Submarines
- Surface Ships
- Target Strength
- Torpedoes

KEYWORDS--Continued

06 Signal Processing

0601 Spatial Processing

Adaptive Beamforming
Amplitude Shading
Analog Beamforming
Array Gain
Binomial Shading
Broadband Beampatterns
Clipped Beamforming
Delay Lines
Digital Beamforming
DIMUS
Directivity Index
Dolph-Chebyshev Shading
Full Beam
Linear Beamforming
Multiplicative Array
Narrowband Beampatterns
Nonparametric
Null Steering
Preformed Beams
Scanning Beams
Split Beam
Supercirectivity
Time Shift and Sum

0602 Temporal Processing

Analog Processing
Automatic Gain Control (AGC)
A/D Conversion
Clipper Correlator
Computer Aided Detection/Classification
Decision Theory
Detector Averager
Digital Processing
Filter Theory
Integrator
Likelihood Ratio
Matched Filter
OR-ing
Polarity Coincidence Correlator
Processing Gain
Replica Correlator
Signal-to-Noise Ratio
Threshold
Time Varying Gain (TVG)
Wave Period Processor

KEYWORDS--Continued

07 Displays and Decision Making

0701 Visual

A-Scan
Bearing-Time Recorder (BTR)
B-Scan
Clutter Rate
Cathode Ray Tube (CRT)
Contrast
Normalization
Plan Position Indicator (PPI)
Visual Integration

0702 Aural

Binaural
Clues
Headphones
Monaural
Signals
Thresholding

0703 Decision Making

Alerted Operator
Computer Aids
Criteria
False Alarms
Human Factors
Information Rate
Operator
Psychoacoustics
ROC Curve
Lighting Conditions

KEYWORDS--Continued

08 Measurement Facilities

0801 Transducer Calibration

- Anechoic
- Beam Patterns
- Diagnostic
- Frequency Response
- High Power Impedance
- In-situ
- Nearfield
- Preproduction
- R & D Testing
- Reference Standards
- Sensitivity
- Shipyard Testing

0802 Sonar Ranges

- Autec
- Dabob Bay
- Foracs
- Sacs
- St. Croix
- NaNOOSE
- Barking Sands

KEYWORDS--Continued

09 System Operational Description

0901 Performance Prediction

- Bearing Errors
- Detection Range
- Dynamic Detection Models
- FOM
- Localization Accuracy
- Probability of Classification
- Probability of Detection
- Range Errors
- Static Detection Models
- Signal Excess
- Tactics

0902 ASW Effectiveness

- Dynamic Encounter Models
- Force Level Studies
- Monte-Carlo Techniques
- Probabilistic Models
- Tactics
- Threat Characteristics

KEYWORDS--Continued

10 Comprehensive References

1001 Texts

Urick, Horton

1002 Manuals

Operating Manuals

1003 Surveys

MOST Committee Reports

DESCRIPTORS

SONAR FUNCTION	ORIENTATION	SONAR SYSTEMS
Active Detection	Theory	ASW
Passive Detection	Measurement	Surface Ship
Active Classification	Survey	AN/SQS-26 (AN,BX,CX)
Passive Classification	Simulation	AN/SQS-23
Localization	Comparison	AN/SQS-35
Tracking	Prediction	AN/SQS-29-32
Communications	Scale Model	AN/SQQ-23 (PAIR)
Navigation	Analytical Model	Active-Submarine
General Applicability	Empirical Model	AN/BQS-6
		AN/SQS-13
		AN/BQS-4
		Active-Helicopter Dipped
		AN/SQA-10
		Passive-Submarine
		AN/BQR-2
		AN/BQR-7
		AN/BQS-13
		AN/BQR-15
		AN/BQS-6
		AN/BQQ-2
		AN/BQQ-3
		AN/BQR-19
		AN/BQR-16
		EXPERIMENTAL
		BRASS
		BAYA
		Advanced Development Systems
		ULMS
		NGSS
		MINEHUNTING
		AN/SQQ-14
		AN/SQQ-16
		Riverine
		CONTACT AVOIDANCE
		AN/BQS-15
		UNDERICE
		AN/BQS-8

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2.2 Feasibility Demonstration

The purpose of the feasibility demonstration was to demonstrate the adequacy of the file structure which had been developed. This was accomplished by designing and conducting a test. The test was developed by the origination of sixteen questions which reflect the needs of potential users of the mobile sonar technology storage and retrieval system. The test was conducted by translating the questions into descriptive words, searching a sample file (discussed below) and listing the document titles which contain the information appropriate to determining the answers to the test questions.

A sample file of reports which were used to demonstrate the feasibility of the system developed as the basis for an information bank and retrieval system was selected from the files in PMS 302.4.

There are approximately 2,000 reports in the files of PMS 302.4 which are considered to be their working files. They are filed randomly with respect to subject, author, and date. The system used now permits document control by the use of three sets of card files - activity, title, and keywords.

It was desired that the feasibility test for the new system be made on a representative sample from the files. So, it was necessary to define a representative sample. Clearly, the statistical test indicated was that of proportion determination. However, it was decided not to run statistical tests to get a sample of the file. As it turned out, what was required for a feasibility demonstration of the logic structure's adequacy was not so much a representative sample as a sample which contained some of each kind of document to be found in the files. It should be noted that if one were testing the mechanics of an information storage

and retrieval system, a truly representative (almost an entire file) sample would be required. But, for our purposes, a sample was required which yielded some kind of document in answer to each question which was asked. The concept of the logic structure was tested by doing this. Otherwise, a testing of the files' contents would have been included in the demonstration. It was to avoid such an occurrence that we generated a sample of 329 documents and then analyzed the sample to judge qualitatively whether or not we had a good sample.

The sample file was made up of the Document Information Extraction Sheets which were designed to contain the pertinent information from 329 documents. (In a storage and retrieval system operation, this would be analogous to indexing the documents). One such sheet is shown on the following page.

The distribution of documents in the sample file according to subject category index is indicated in Table I. In Tables II, III, and IV are shown the sample contents with respect to Sonar Function, Orientation, and Sonar System. Correlations between these major descriptors were not performed as they were not needed.

2.2.1 Testing - The testing of the file structure was accomplished by taking a four step approach--(1) developing the questions which would be typical of questions appropriate for an information storage and retrieval system, (2) translating the questions into the language of the system (viz, descriptive words), (3) searching the sample file for titles of appropriate documents, and (4) selection of the document titles and information extraction sheets for later evaluation of test results.

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302.4 File No.	000 015
Originating Orgzn.	General Electric Co., Heavy Military Elec. Sys.
Originating Orgzn. Location	Syracuse, New York
Title	A Design for a Digital Phase and Delay Beamformer for Planar Array Sonar
Personal Author	Dickey, Jr., F. R.
Publication Date	Sept. 67 No. of Pages 108
Doc. No. Orign. Orgzn.	R67EMH31
U.S. Rpt. Series No.	
Contract No.	
Project Serial No.	
Task	
Document Type	Proposal
Security Class.	Confidential Group 4
Distribution Limitations	
Note	

DESCRIPTIVE WORD ELEMENTS:

Sonar Function	09	
Orientation	05	
Sonar System	X	
Subject Category	06	0601
Key words	Beam formers	Conformal Arrays
	Phase shifting, filtering, analog to digital conversion	Planar Arrays

Prepared by: FS Date: 8/3/71 Reviewed by: Date:

TABLE I

SUBJECT CATEGORY INDEX

Document Type			Number
01	Acoustic Signal Transformation		(51)
	0101	Signal general and control	10
	0102	Array configurations	5
	0103	High power transducers	1
	0104	Hydrophones	1
	0105	Measurements	9
	0106	Materials	5
	0107	Design constraints	17
	0108	Design aids	1
	0109	Reliability	2
02	Domes		(13)
	0201	Physical properties	6
	0202	Acoustical properties	7
03	Acoustics and Oceanography		(52)
	0301	Oceanographic factors	17
	0302	Scattered field	12
	0303	Noise field	--
	0304	Target characteristics	--
	0305	Acoustic propagation theory	23
	0306	Signal field	--
04	Noise		(17)
	0401	Ambient noise	8
	0402	Self-noise	9
05	Target Characteristics		(13)
	0501	Radiated noise	2
	0502	Reflection properties	11

TABLE I--Continued

Document Type		Number
06	Signal Processing	(74)
	0601 Spatial processing	12
	0602 Temporal processing	62
07	Man-Machine Interface	(15)
	0701 Displays	6
	0702 Human factors	1
	0703 Phychoacoustics	1
	0704 Measurements	1
	0705 Training	5
	0706 Design Characteristics	1
	0707 Console	-
	0708 Controls	--
08	Sonar and Transducer Testing	(6)
	0801 Transducer calibration	3
	0802 Facilities	1
	0803 Equipment	1
	0804 Techniques	1
09	System Operation/Description	(64)
	0901 Performance prediction	15
	0902 ASW effectiveness	10
	0903 Reliability	5
	0904 Maintainability	3
	0905 Measured performance	25
	0906 Utilization	6
10	Comprehensive Texts	(24)
	1001 Texts	--
	1002 Manuals	2
	1003 Surveys	22

TABLE II

SONAR FUNCTION

Function		No. of Documents
01	Active Detection	31
02	Passive Detection	25
03	Active Classification	20
04	Passive Classification	4
05	Localization	2
06	Tracking	5
07	Acoustic Communications	2
08	Navigation	1
09	General Applicability	47

TABLE III

ORIENTATION

Orientation		No. of Documents
01	Laboratory Measurements	8
02	Field-Test Measurements	16
03	Range Measurements	0
04	Operational Measurements	6
05	General Theoretical Principles	71
06	Implementation of Theory	8
07	Model	26
08	Simulation	12
09	Survey	52
10	Comparison (Evaluation)	75
11	Standards	6
12	Equipment Description	11
13	Equipment Description	9

TABLE IV

SONAR SYSTEM

System	No. of Documents
AN/AQA-5	2
AN/AQS-10	1
BQQ-2	1
BQR-2B	5
BQR-2C	1
BQR-2( ) DIMUS	4
BQR-7	1
BQS-5	2
BQS-6	2
BQS-13	4
SQA-13/35	1
SQQ-23 PAIR	2
SQS-23	9
SQS-23 TRAM	4
SQS-26 AX	1
SQS-26 BX	6
SQS-26 CX	23
SQS-26 (XN-2)	11
SQS-35	2
BRASS II	4
BRASS III	4
BQR-7 DIMUS	2
SQA-10	1
BQS-6B	2
BRASS	1
PADLOC	3
BQS-6A	1
BQA-8	1
BQR-7B	1

The view taken in the development of the test questions was that there are two basic groups of potential users of the system--managers (including sponsors of the exploratory development effort) and researchers. Accordingly, two groups of questions were constructed to reflect the interests peculiar to both groups. The questions were designed using some existing needs as bases. The questions based on managers' needs are referred to below as Type I. Those reflecting needs of researchers are denoted Type II.

Type I Questions

1. What reports describe the state-of-technology in sonar displays with respect to the human engineering involved?

2. What are the limiting information (or data) processing rates for sonar operators; and, what data-rate-reduction techniques exist?

3. Are there reports availabe on the elimination of sonar self-noise lines which show up on submarine passive sonar Bearing-Time Recorders?

4. What are the characteristics of ambient noise which influence submarine sonar performance?

5. Are data available on the spectral characteristics of submarine radiated noise signatures?

Type II Questions

Though there are many researchers' needs which arise which call for summary data, by far the greatest need is to

ascertain which documents contain specific technological area data so that they may be acquired. Therefore, the questions listed below relate to specific information assumed to be in the documents listed in the sample file.

Questions Relating to Information in Documents

1. What reports are available on the baffling and mounting techniques used on the SQS-26-type bow array?

2. What measurements have been made on the dome-array element interaction (acoustic) on hull mounted sonars for surface ships?

3. What data are available on the reflection of broad band acoustic energy from the ocean bottom?

4. What are the directional characteristics with respect to ocean depth of ambient sea noise?

5. What are the major highlights which can be detected in sonar echoes off U. S. submarines?

6. What are the characteristics of an optimal temporal processor for active sonar detection?

7. What is the difference between performance estimates for a broad band passive sonar when using a center-frequency Directivity Index and when using a beamformer model?

8. What is the expected improvement in active sonar performance in using color coded displays?

9. Are data available on the expected patrol degradation of transducer calibration for surface ship sonars?

10. How much validation data exist for Figure of Merit performance prediction models?

11. Are survey type data available on acoustic energy bottom loss values for the North Atlantic?

After the development of the questions, the straightforward task of translating the questions and searching the sample file was accomplished. The following discussion is presented in order to illustrate the translation process. To understand the translation step however, it is necessary that a brief review of the concept of filing and retrieving developed under this contract be presented.

The logic structure for mobile sonar technology developed under this contract calls for the description (and hence the accession) of a document to consist of a "descriptive word" rather than the more common set of key words. On page 25 is an example of the information extracted from each of 329 file documents contained in PMS 302.4's library. In a storage and retrieval system operation, this would be a worksheet for indexing the documents. In our case, the sheets were used for document identification and for generating the descriptive words. The sheets themselves constituted the sample file.

Emphasis was placed on the descriptive word elements in the information extraction, since this is the key to the adequacy of the system proposed. The sheet on page 25 shows the descriptive word for that particular document described to be the following:

06	0601	(···)	09	05	X
Subject Category	Sub-Cat.	Key Words	Sonar Function	Orienta-tion	Sonar System

Note: See Appendices for code to descriptive word elements entries.

Now it becomes obvious that the translation of the test questions amounted to the generation of descriptive words by looking at the questions. An example of such a translation appears below.

Question: What reports are available on the baffling and mounting techniques used on the SQS-26 type bow array?

Descriptive Word: [04; 0402; (...); 09; 07, 12; 61-62-63-64]

In order to provide a way to measure the adequacy of the descriptive word system beyond that of evaluation of the retrieval list, the test included searching the sample file on a key word basis; thus, making a comparison possible.

It should be noted here that the actual tester had virtually no experience in the area of sonar. He would qualify

as a reasonably able indexer. The tester took the list of questions, translated them, searched the sample file for matches, and tabulated the matches by question.

The search of the sample file using the questions translated into descriptive words was conducted manually. As noted earlier, the sample file consisted of the kind of sheet shown on page 25 of this report. Therefore, the "search" amounted to taking the descriptive words and comparing them with each information sheet and recording the matches. The results of the searches were indicated by lists of identifying document file numbers according to question. These results are presented and discussed below.

2.2.2 Results - The results of the system feasibility test described in this report are shown in terms of retrieval performance in the table on page 36. As indicated by the table, the following ratios were tabulated:

1. Relevant/Total--where,
   Relevant ≡ the number of documents relevant to the question and retrieved;

   Total ≡ the number of documents retrieved.

2. Recall Ratio ≡ the number of documents relevant and retrieved divided by the number of documents in the sample file relevant to the question.

RESULTS

Questions	Retrieval Performance		
	Descriptive Words		Key Words
	Relevant/Total	Recall Ratio	Relevant/Total
Type I			
1	12/15	12/12	1/15
2	4/13	4/4	0/13
3	0/3	0/0	0/3
4	14/19	14/16	0/19
5	0/1	0/1	0/1
Type II			
1	0/0	0/0	0/0
2	3/3	3/4	0/3
3	22/37	22/23	1/37
4	6/7	6/6	0/7
5	0/2	0/1	1/2
6	29/37	29/30	0/37
7	4/8	4/4	0/8
8	0/20	0/0	0/20
9	2/3	2/2	0/3
10	18/29	18/18	0/29
11	10/11	10/10	0/11
	Ave. = 5/9 = 55%	Ave. = 6/7 = 85%	Ave. = 1/93 = 1%

Judgments of relevancy were made by the author. The translation of the questions were checked and corrected before searches were made; and, each of the retrievals was checked for relevancy. Determination of sample file content relevant to each question was made by the author.

It can be seen from the results of the test that, clearly, the descriptive word approach to information storage and retrieval offers much improvement over the key word approach.

2.3 Final Design

There have been critical reviews of the descriptive word storage and retrieval system concept, developed under this contract, both by the project engineers in PMS 302.4 and by members of laboratories and TRACOR. Through such reviews and the analysis of the feasibility test results, very few changes have been made to the "system" design.

Because the implementation of a retrieval system was beyond the scope of this contract, the final design of the descriptive word system is like the initial design but it is more complete. Appendices A, B, and C contain the final sets of categories, sub-categories, keywords, and other elements of the descriptive words.

The utility of the development of this concept of descriptive word filing and retrieving lies in its sensitivity and flexibility. The results of the retrieval capability demonstrated by the tests show the sensitivity. The flexibility will be demonstrated by the integration of the descriptive word concept into any library containing technical reports concerning mobile sonar technology.

3.0 CONCLUSIONS

The descriptive word approach to the storage and retrieval of technical documents concerning mobile sonar technology has been developed and tested as far as it should be, as such, within the scope of this contract. The details of the system have been presented to representatives of activities who could now take steps to use the system thus far developed.

Consequently, the work under this contract to date has made several conclusions possible; they are discussed below.

1. The test results show convincingly that the objective of this contract work has been met; that is to say, the essence of a feasible mobile sonar technology information storage and retrieval system has been developed and demonstrated. It has been named a descriptive word system.

2. Using the concept of the descriptive word system, a centralized library could be established in a straight forward manner to be the service library for mobile sonar technology documentation.

3. Any retrieval system based upon accession of documents utilizing a multidimensional technique (e.g., descriptive word elements) will surpass in performance a system based upon accession using solely keywords.

4. From investigations of existing systems at various libraries and documentation centers, it is concluded that the SHARPS used by the NAVSHIPS Technical Library could most easily accommodate the descriptive word approach.

The recommendations which are based on the conclusions above and the experience gained while performing the work to date are given in the following section.

4.0 RECOMMENDATIONS

As a result of the work to date under this contract, TRACOR makes the following recommendations:

- The remainder of the contract work be that of consulting with PMS 302.4 and the NAVSHIPS Library to assist in the integration into their retrieval system the descriptive word approach.

- Assist in the construction of a mobile sonar technology library at a U. S. Navy research and development center.

- A mechanized or automated system be developed using the descriptive word approach so that expanded utilization may be achieved.

- PMS 302.4 should publish bi-annually Summaries of Mobile Sonar Technology.

- The concept of a descriptive word retrieval system should be extended to cover all sonar technology.

5.0 REFERENCES

1. "Preliminary Compilation, Sonar Terminology," December 15, 1971, Prepared by TRACOR, Inc., Prepared for Sonar Technology Div.

TRACOR 6500 TRACOR LANE, AUSTIN, TEXAS 78721

APPENDIX A

SUBJECT CATEGORY INDEX

SUBJECT CATEGORY INDEX

(Including Sub-Categories)

01 Acoustic Signal Transformation
- 0101 Signal generation and control
- 0102 Array configurations
- 0103 High power transducers
- 0104 Hydrophones
- 0105 Measurements
- 0106 Materials
- 0107 Design constraints
- 0108 Design aids
- 0109 Reliability

02 Domes
- 0201 Physical properties
- 0202 Acoustical properties

03 Acoustics and Oceanography
- 0301 Oceanographic factors
- 0302 Scattered field
- 0303 Noise field
- 0304 Target characteristics
- 0305 Acoustic propagation theory
- 0306 Signal field

04 Noise
- 0401 Ambient noise
- 0402 Self-noise

05 Target Characteristics
- 0501 Radiated noise
- 0502 Reflection properties

06 Signal Processing
- 0601 Spatial processing
- 0602 Temporal processing

SUBJECT CATEGORY INDEX--Continued

07 Man-Machine Interface
- 0701 Displays
- 0702 Human factors engineering
- 0703 Phychoacoustics
- 0704 Measurements
- 0705 Training
- 0706 Design characteristics
- 0707 Console
- 0708 Controls

08 Sonar and Transducer Testing
- 0801 Transducer calibration
- 0802 Facilities
- 0803 Equipment
- 0804 Techniques

09 System Operation/Description
- 0901 Performance prediction
- 0902 ASW effectiveness
- 0903 Reliability
- 0904 Maintainability
- 0905 Measured performance
- 0906 Utilization

10 Comprehensive Texts
- 1001 Texts
- 1002 Manuals
- 1003 Surveys

APPENDIX B

KEYWORDS

KEYWORDS

01 ACOUSTIC SIGNAL TRANSFORMATION

0101 Signal Generation and Control

Amplifiers, fluid
Amplifiers, linear
Amplifiers, switching
Beam formers
Beam steerers
Duty cycle
Electrical dummy loads
Multistate modulation
Power storage
Pulse width
Repetition rate
Signal programming
Signal switching
Super flywheel
System monitors

0102 Array Configurations

Biplanar
Conformal
Cylindrical
Line
Planar
Spherical
Towed
Variable depth sonar

0103 High Power Transducers

Blenders
Flextensional
Free-flooded rings
Hydroacoustic
Lens
Longitudinal vibrator
Variable reluctance

0104 Hydrophones

KEYWORDS--Continued

0105 Measurements

Dummy load
Explosive shock
Free-field
Holography
Nearfield
Pressure tank
Reciprocity
Tank

0106 Materials

Adhesives
ADP crystals
Barium titanate
Encapsulation
Filler, gas
Filler, oil
Lead metaniobate
Lead zirconate titantate
Plastic
Rubber
Uniformity

0107 Design Constraints

Beam pattern
Beam width
Cavitation
Configuration
Current control
Directivity
Efficiency
Goodness criteria
Harmonics
Head flexing
Interaction
Interstices
Isolation
Isolation mounts
Major lobe
Minor lobe
Mutual coupling
Packing factor
Polarization

KEYWORDS--Continued

Power sensitivity
Pressure release
Sensitivity
Shading
Shape factor
Shock hardening
Source level
Surface area
Transmissivity
Tuning
Voltage control
Volume
Weight

0108 Design Aids

Computer programs
Distributed parameters
Equivalent circuits
Finite element
Iterative process
Lumped parameters
Material standards
Mathematical models
Scale models

0109 Reliability

Cavitation
Corona
Degassing
De-poling
Failures
Histories
Permeation
Prestress
Prestress, bias rod
Prestress, fiber glass wrap
Voltage breakdown

KEYWORDS--Continued

02 DOMES

0201 Physical Properties

Corrosion resistance
Durability
Flow properties
Fouling
Hardness
Shape
Strength
Weight

0202 Acoustical Properties

Absorption coefficient
Array-dome interaction
Cavitation
Quenching
Reflection coefficient
Transmission coefficient

03 ACOUSTICS AND OCEANOGRAPHIC

0301 Oceanographic Factors

Internal waves
Thermal front
Time series

0302 Scattered Field

Scattering strength
Scattering coefficient
Grazing angle
Reverberation strength (level)
Reverberation distribution (spatial, temporal)
Bottom Loss
Scattering Layer

KEYWORDS--Continued

0303 Noise field

Noise level
Noise distribution (temporal, spatial)
Biological
Hydrodynamic
Machinery

0304 Target Characteristics

Target strength
Target coherence
Target reradiation
Target energy distribution
Echo structure
Target strength of fish

0305 Acoustic Propagation Theory

Normal mode propagation
Ray
Convergence zone
Refracted surface reflected
Bottom bounce
Surface dust

0306 Signal Field

Signal spatial coherence
Signal temporal coherence

04 NOISE

0401 Ambient Noise

Biological noise
Data bank
Directionality
Isotropicity
Sea state
Seismic noise
Shipping noise
Spatial coherence
Stationarity
Surface generated noise
Turbulence
Wind speed

KEYWORDS--Continued

0402 Self-Noise

Baffles
Cavitation
Flow-induced noise
Isotropicity
Machinery noise
Propeller noise
Ship speed
Spatial coherence
Thermal noise
Turbulence

05 TARGET CHARACTERISTICS

0501 Radiated Noise

Aircraft carriers
Continuous spectrum
Destroyers
Diesel electric submarines
Hydrodynamic noise
Line component spectrum
Machinery noise
Nuclear submarines
Propeller noise
Ship speed
Torpedoes

0502 Reflection Characteristics

Aspect angle
Doppler shift
Echo structure
Energy splitting
Fish
Mines
Pulse length
Submarines
Surface ships
Target strength
Torpedoes

KEYWORDS--Continued

06 SIGNAL PROCESSING

0601 Spatial Processing

Adaptive beamforming
Amplitude shading
Analog beamforming
Array gain
Binomial shading
Broadband beampatterns
Clipped beamforming
Delay lines
Digital beamforming
DIMUS
Directivity Index
Dolph-Chebyshev shading
Full beam
Linear beamforming
Multiplicative array
Narrowband beampatterns
Nonparametric
Null steering
Preformed beams
Scanning beams
Split beam
Superdirectivity
Time shift and sum

0602 Temporal Processing

Analog processing
Automatic Gain Control (AGC)
A/D conversion
Clipper correlator
Computer aided detection/classification
Decision theory
Detector averager
Digital processing
Filter theory
Integrator
Likelihood Ratio
Matched Filter
OR-ing

KEYWORDS--Continued

Polarity coincidence correlator
Processing gain
Replica correlator
Signal-to-noise ratio
Threshold
Time Varying Gain (TVG)
Wave period processor

07 DESIGN CONSTRAINTS

0701 Displays

Visual

Acuity
A-scan
Alphanumeric
Bearing-Time Recorder (BTR)
B-scan
Cathode Ray Tube (CRT)
Classification
Clutter rate
Color coded
Contrast
Detection
Display Data Requantization (DDR)
Integrated
Lofargram
Normalization
Overlays
Plan Position Indicator (PPI)
Recognition differential
Resolution
Scaling
Size
Symbology
Three dimensional (functional)
Three dimensional (physical)
Tracking
Visual integration
Warning

KEYWORDS--Continued

Aural

Binaural
Classification
Clues
Damage
Detective
Filters
Frequency
Headphones
Listening
Loudness
Masking
Monaural
Multichannel listening
Noise
Pitch
Protective devices
Recognition differential
Signals
Threshold
Threshold shift
Warning devices

0707 Human Factors Engineering

Methods of Analysis

Activity
Decision
Error
Experimental
Factor analysis
Flow
Functional
Information requirements
Modeling
Monte Carlo
Operational testing
Simulation
Task

KEYWORDS--Continued

System Design

- Channel capacity
- Communications
- Decision making
- Human reliability
- Information rate
- Learing
- Motivation
- Sensory interaction
- Signal detection

Dynamic

- Gain
- Integration
- Reaction time
- Tracking
- Transfer functions

Workplaces

- Dimensions
- Layout
- Seat design
- Viewing angle
- Viewing distance

Environment

- Acoustic levels
- Dark adoption
- Lighting

Operator Characteristics

- Age
- Alerting
- Biodata
- Boredom
- Diver safety
- Experience
- Fatigue
- Hearing loss
- Intellectual performance
- Motor performance

KEYWORDS--Continued

Performance degradation
Risk taking
Safety
Speech distortion
Vigilance

0703 Psychoacoustics

Correlation
Detection
Intensity
Localization
Noise
Phase
Signal
Theory
Threshold

0704 Measurements

Performance

Anthropometry
At-sea tests

Modeling

Computer
Laboratory
Simulation

Mathematical

ROC
Statistical

0705 Training

Aids and Devices

Computers
Films
Manuals and guides, instructor
Manuals and guides, technical
Manuals and guides, trainee
Mock-ups and models
Slides and transparencies

KEYWORDS--Continued

Teaching machines
Television
Trainers and simulators
Courses

Basic learning data

Characteristics of learner
Distribution of practice
Knowledge of results
Length of training
Motivation
Retention
Set and attention
Theories of learning
Transfer
Whole vs. part

Comparison of methods
Evaluation of programs
Fleet schools
Learning objectives

Specific types

Basic
Factory
Instructor
Maintenance
Operator
Programmed
Sonar
Submarine
Team (ASW)
Tracking and motor skills

0706 Design Characteristics

Physical

Bandwidth
Cathode ray tube (CRT)
Chart recorder
Color gun
Clutter
Filter

KEYWORDS--Continued

Flicker
Glare
Gray scale
Phosphor
Safety
Size

Computer

Access
Bit rate
Capacity
Speed
Storage

0707 Console

Integrated

Control-display associations
Layout
Multifunction
Multimanned
Single-manned

Special purpose

Physical characteristics

Control-display grouping
Shape
Size
Spacing
Viewing angle
Viewing distance

0708 Controls

Coding
Handedness
Movement
Multifunction
Resistance
Shape
Size
Spacing between

KEYWORDS--Continued

08 MEASUREMENT FACILITIES

0801 Transducer calibration

Anechoic
Beam patterns
Diagnostic
Frequency response
High power impedence
In-situ
Nearfield
Preproduction
R & D testing
Reference standards
Sensitivity
Shipyard testing

0802 Sonar ranges

Autec
Barking Sands
Dabob Bay
Foracs
NaNOOSE
Sacs
St. Croix

09 SYSTEM OPERATIONAL DESCRIPTION

0901 Performance Prediction

Bearing errors
Detection range
Dynamic detection models
FOM
Localization accuracy
Probability of classification
Probability of detection
Range errors
Static detection models
Signal excess
Tactics

KEYWORDS--Continued

0902 ASW Effectiveness

Dynamic encounter models
Force level studies
Monte Carlo techniques
Probabilistic models
Tactics
Threat characteristics

0903 Reliability

0904 Maintainability

0905 Measured Performance

0906 Utilization

10 COMPREHENSIVE TEXTS

1001 Texts

Horton
Urick

1002 Manuals

Operating Manuals

1003 Surveys

MOST Committee reports
Labs Reviews
SACLANT CENTRE
AMOS
FASOR
MGS
Bibliographies

APPENDIX C

DESCRIPTORS

SONAR FUNCTION

01 ACTIVE DETECTION: The process of determining that a possible target (submarine, mine, torpedo, swimmer) is present in which an active sonar system transmits energy, and it is observed that the received echo contains the effects of having reflected off of a target.

02 PASSIVE DETECTION: The process of determining that a possible target is present in which acoustic information is received by a passive sonar system; and, it is observed to contain the effects of energy radiated from a target.

03 ACTIVE CLASSIFICATION: A decision process in which received echoes in an active sonar system are analyzed and sorted into target and non-target categories. In general, the detection process will have been completed before classification is performed.

04 PASSIVE CLASSIFICATION: A decision process in which the acoustic information received by a passive sonar system is analyzed (usually involving narrowband frequency analysis), and identification is made of target generated noise.

05 LOCALIZATION: A process in which a determination is made, using a sonar system, of the range to a target under surveillance and the relative azimuthal position of the target with respect to own-ship (viz, bearing). Processing equipment in addition to that used for detection and classification is generally required.

06 TRACKING: A function which is performed by a sonar system in which contact with a target is maintained for an unspecified amount of time. The contact maintenance is accomplished using the detection/classification and localization portions of the system.

07 COMMUNICATIONS (ACOUSTIC): A function performed by an underwater acoustic system whereby information is passed from one party to another (e.g., submarine to surface ship).

08 NAVIGATION: A process in which geographical location is determined by any of a set of acoustic systems, radar systems, and visual systems.

09 GENERAL APPLICABILITY: An indication that the subject document addresses three or more of the above listed functions.

ORIENTATION

01 LABORATORY MEASUREMENTS: Any measurements at facilities such as contractor plants, Navy labs, etc.

02 FIELD-TEST MEASUREMENTS: Those made at sites away from the plant or laboratory--such as, for example, lake stations, or at-sea but without the use of Fleet assistance.

03 RANGE MEASUREMENTS: Those made at operational ranges such as TOTO, FORACS, etc.

04 OPERATIONAL MEASUREMENTS: Those made at sea using Fleet vessels and carried out under operational conditions.

05 GENERAL THEORETICAL PRINCIPLES: Applicable to documents which deal with basic concepts of the field of Sonar Technology--physics, acoustics, oceanography, underwater acoustic propagation theory, mathematics, signal detection theory, decision theory, filter theory, stress-strain relations in transducer material, etc. These documents deal with subjects which are completely general, and the sonar applications are to be deduced.

06 IMPLEMENTATION OF THEORY: This phrase is used to identify those documents which describe equipments (not systems) of the breadboard variety which are implementations of theoretical developments.

07 MODEL: An analytical (meaning mathematical) or physical image, or copy, of a process, a system which can be used to represent that process or system.

08 SIMULATION: A mathematical or physical process or device which is a counterfeit process or device which is built to yield the same results when operated as some other process or device.

09 SURVEY: An attempt to describe a process, a parameter, or a phenomenon in general, so as to yield a reference volume for all specific applications--examples are AMOS, MGS, FASOR.

10 COMPARISON (EVALUATION): An activity in which measurements are made to test the sufficiency and proficiency of theoretical concepts.

11 STANDARDS: Sets of values for specific parameters which serve as expected values (anticipated and/or required). These could be measurements or theoretically determined characteristics. Examples: FORACS reports, specifications.

12 TECHNIQUES: a) Generally accepted or required procedures for testing;

b) Applications of theoretical developments which do not uniquely imply sonar usage--e.g., signal processing techniques.

13 EQUIPMENT DESCRIPTION: Such documents which mainly enumerate and characterize the essential aspects of equipment--e.g., a Technical Operating Manual.

SONAR SYSTEM NOMENCLATURE

1. AN/AQA-5
2. AN/AQS-10
3. AN/BQA-7B
4. AN/BQG-1
5. AN/BQG-2A
6. AN/BQH-1
7. AN/BQH-1A
8. AN/BQH-2D
9. AN/BQQ-1
10. AN/BQQ-2
11. AN/BQQ-3
12. AN/BQR-2B
13. AN/BQR-2C
14. AN/BQR-2( ) DIMUS
15. AN/BQR-4
16. AN/BQR-4A
17. AN/BQR-7
18. AN/BQR-7 DIMUS
19. AN/BQR-7B
20. AN/BQR-15
21. AN/BQR-16
22. AN/BQR-19
23. AN/BQS-2
24. AN/BQS-4
25. AN/BQS-5
26. AN/BQS-6
27. AN/BQS-6A
28. AN/BQS-6B
29. AN/BQS-8
30. AN/BQS-11
31. AN/BQS-12
32. AN/BQS-13
33. AN/BQS-13 DNA
34. AN/BQS-15
35. AN/FQQ-1
36. AN/FQR-1
37. AN/FQS-4
38. AN/FQS-13
39. AN/PQC-1
40. AN/PQS-1
41. AN/SQA-10
42. AN/SQA-10/29
43. AN/SQA-11
44. AN/SQA-13/35
45. AN/SQA-17
46. AN/SQN-( ) (XN-2)
47. AN/SQQ-3
48. AN/SQQ-5 thru 8
49. AN/SQQ-14
50. AN/SQQ-16
51. AN/SQQ-18A
52. AN/SQQ-23 PAIR
53. AN/SQQ-36 (XN-2)
54. AN/SQR-13
55. AN/SQS-4
56. AN/SQS-10
57. AN/SQS-11
58. AN/SQS-13
59. AN/SQS-17
60. AN/SQS-18

SONAR SYSTEM NOMENCLATURE--Continued

61. AN/SQS-19
62. AN/SQS-21
63. AN/SQS-21 (XN-1)
64. AN/SQS-23
65. AN/SQS-23A
66. AN/SQS-23 TRAM
67. AN/SQS-26
68. AN/SQS-26AX
69. AN/SQS-26BX
70. AN/SQS-26CX
71. AN/SQS-26 (XN-2)
72. AN/SQS-29 thru 32
73. AN/SQS-35
74. AN/SQS-38
75. AN/SQS-503A
76. AN/SQS-505
77. AN/SQS-507
78. AN/SSQ-30
79. AN/SSQ-41
80. AN/SSQ-47
81. AN/SWS-10
82. AN/SYA-4
83. AN/UQN-1
84. AN/UQX-3
85. AN/USQ-20
86. AN/UQS-1
87. AN/UQS-1B
88. AN/UQS-2
89. AN/UQS-3
90. AN/WQC-1
91. AN/WQC-2
92. AN/WOM-2 (XN-1)
93. AN/WQR-1
94. BRASS
95. BRASS II
96. BRASS III
97. ULMS
98. MID-70
99. NGSS
100. LORAD
101. PADLOC
102. AN/BQA-8

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PMS 302.4

13. ABSTRACT

This report describes the development of the basis for a mobile sonar technology information storage and retrieval system which will induce centralization of the appropriate documents into a library and will provide a reasonable method of accession to the desired documents. The work herein described has produced a concept which has been named the "descriptive word" approach to information storage and retrieval.

The development of the descriptive word system involved first the organization of mobile sonar technology into ten categories which were derived from an overview of the physical process of a sonar system operating in its intended environment; the categories were further subdivided. Next, elements to describe other aspects of a document were generated. These are the sonar function concerned with, the general orientation of the subject, the key words, and finally the notation of any specifically designated sonar systems.

DD FORM 1 NOV 65 1473 352 100

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Document Retrieval						
Accession						
Information Storage						
Descriptors						
Sonar Technology						